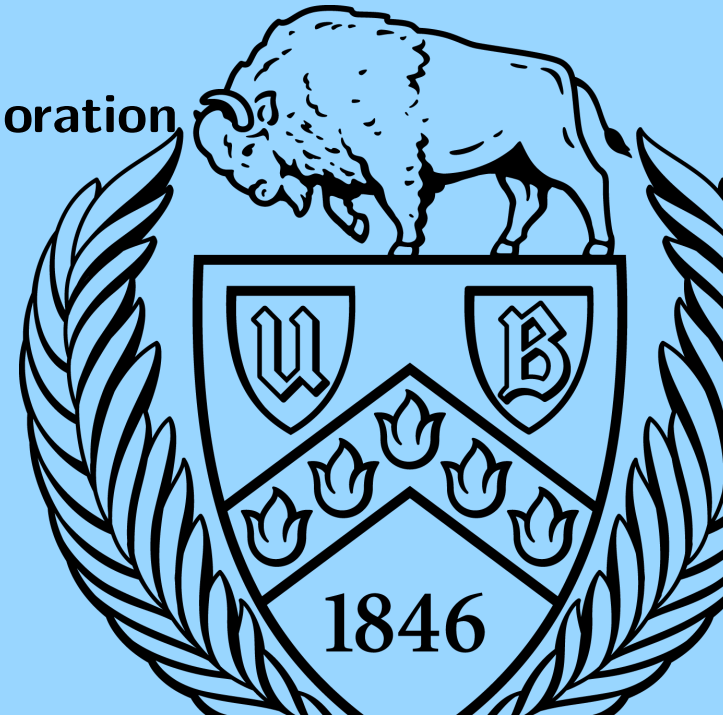
Search for $t\bar{t}$ resonances in proton proton collisions at 13 TeV

Bahareh Roozbahani

on behalf of the CMS collaboration

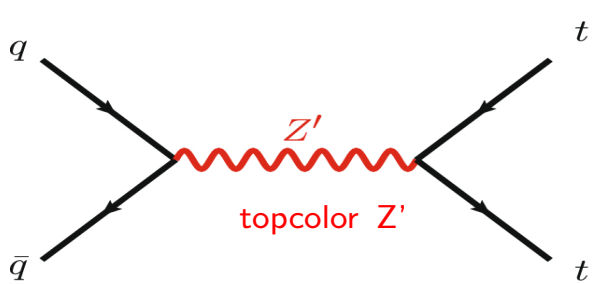
2018 USLUA Meeting



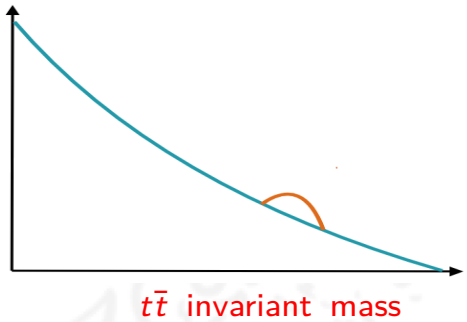
October 26, 2018

Motivation

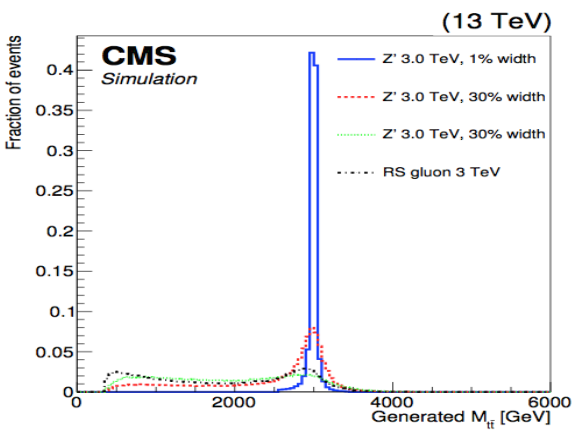
- Many BSM predict heavy resonance with enhanced gauge coupling to 3rd generation quark

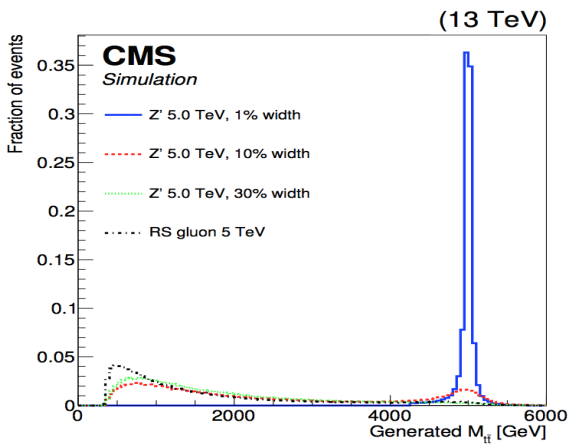


- Bump on top of SM $t\bar{t}$ continuum $\longrightarrow$ possible discovery



- Top couplings and widths are different in models above





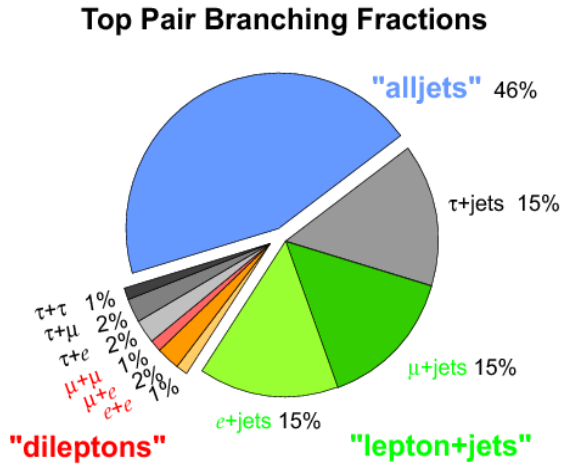
Signals generated with various width and mass points

Z' generated by MADGRAPH5

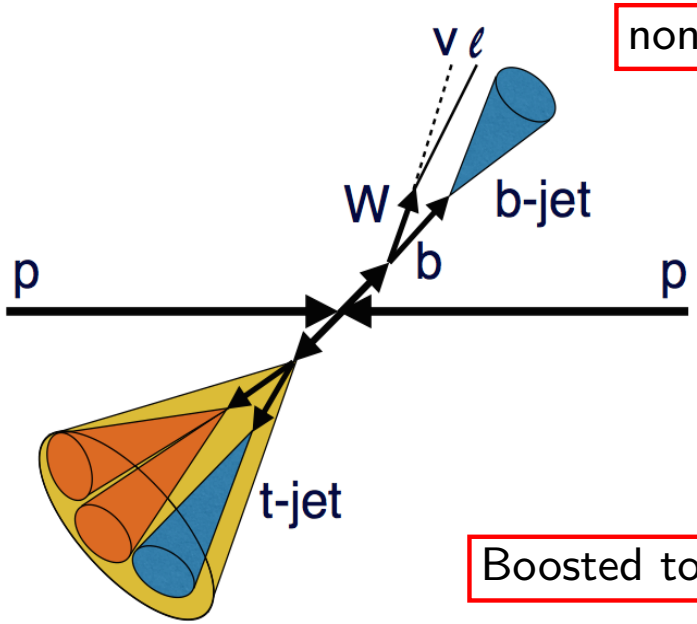
g_{kk} generated by PYTHIA8

Search for $t\bar{t}$ resonances

- Final states:
  - Dileptonic: $Z' \rightarrow t\bar{t} \rightarrow l\nu b + l\nu b$
  - Semileptonic: $Z' \rightarrow t\bar{t} \rightarrow l\nu b + jjb$
  - Hadronic: $Z' \rightarrow t\bar{t} \rightarrow jjb + jjb$



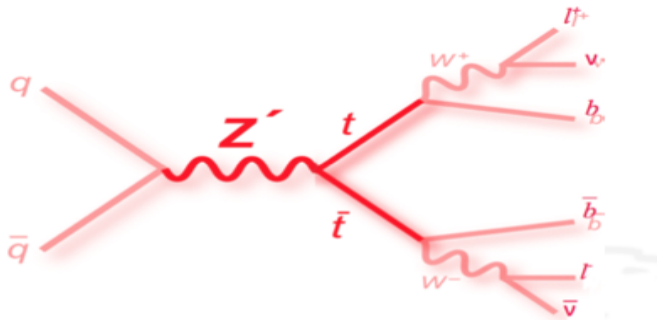
- Dealing with the heavy resonances → boosted top and anti-top



non-Isolated leptons

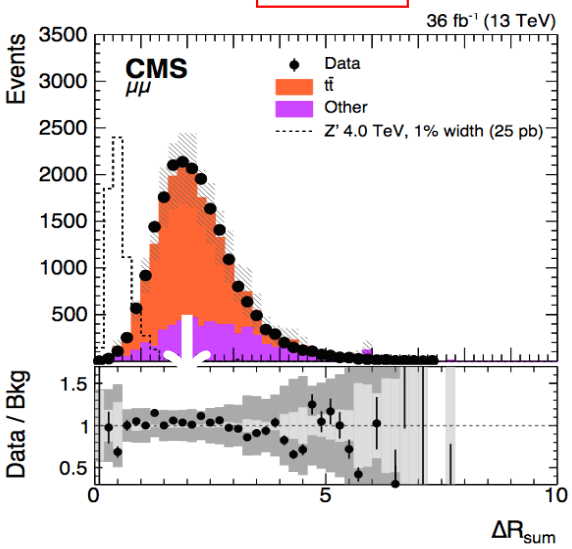
Boosted top-tagged jets

Leptonic channel: categorization

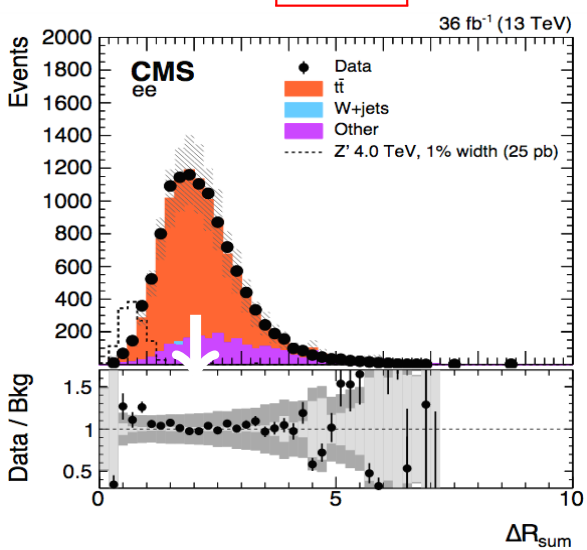


Defining control/signal regions→ using discriminator $\Delta R_{min0} + \Delta R_{min1}$

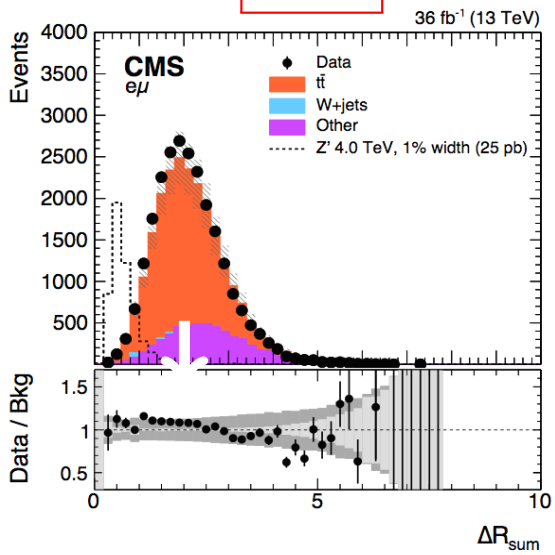
$\mu + \mu$



$e + e$



$e + \mu$

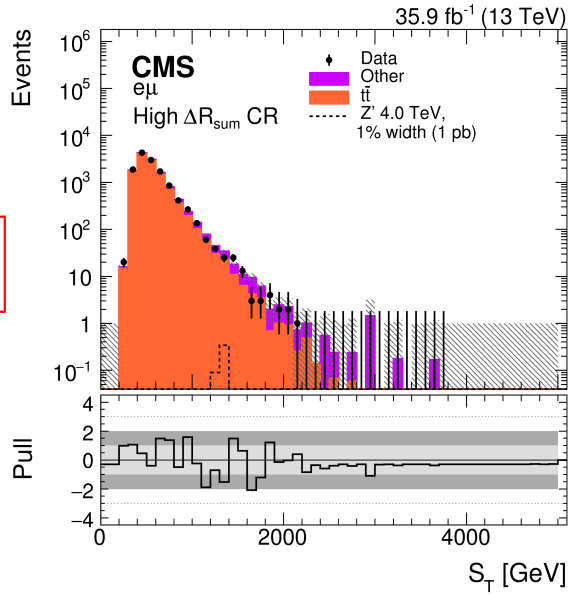


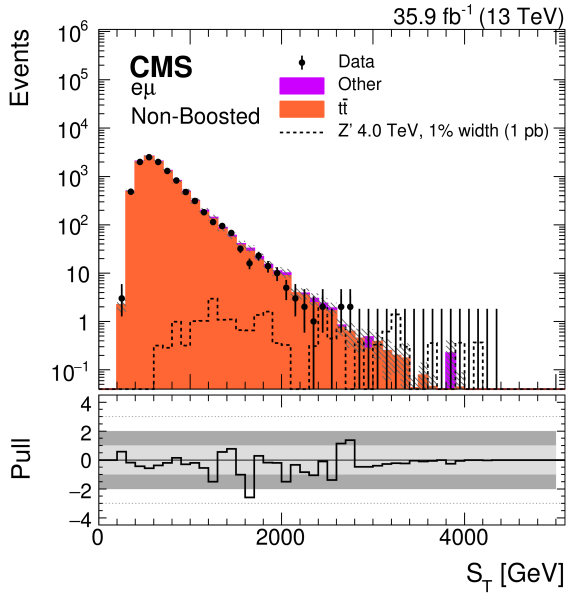
2 signal and 1 background categories defined based on ΔR_{sum}, for each of $\mu\mu$, ee and $e\mu$ channels

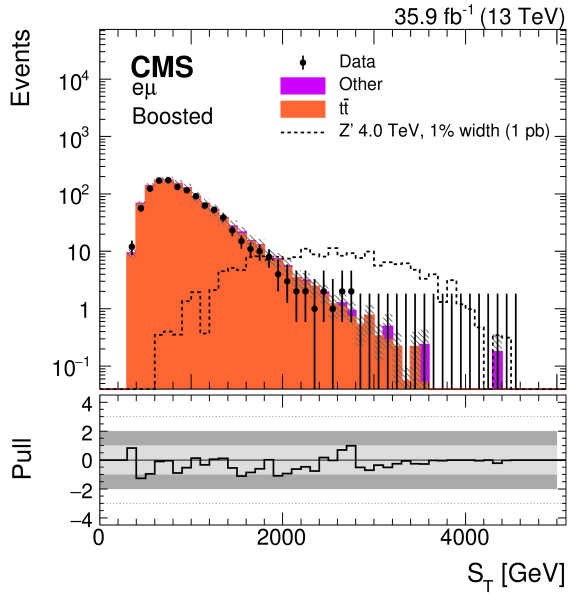
Leptonic channel: sensitivity variable

Control Region | **Non-Boosted Region** | **Boosted Region**

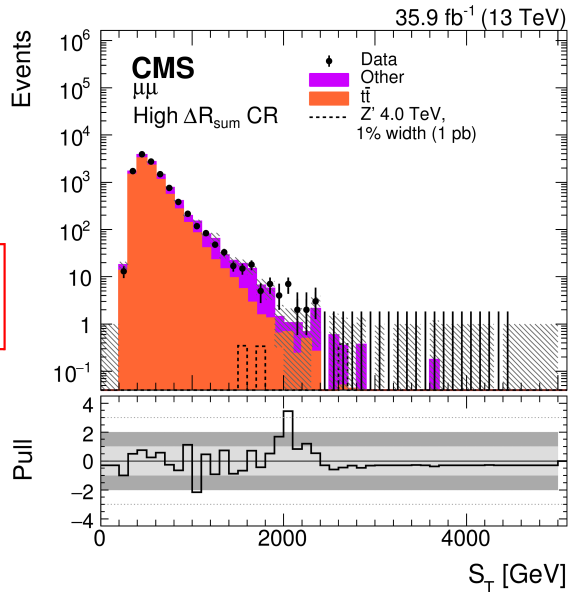
$e\mu$

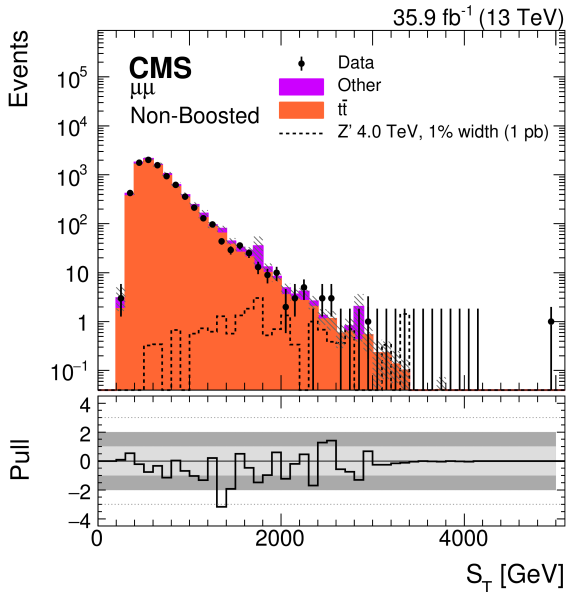


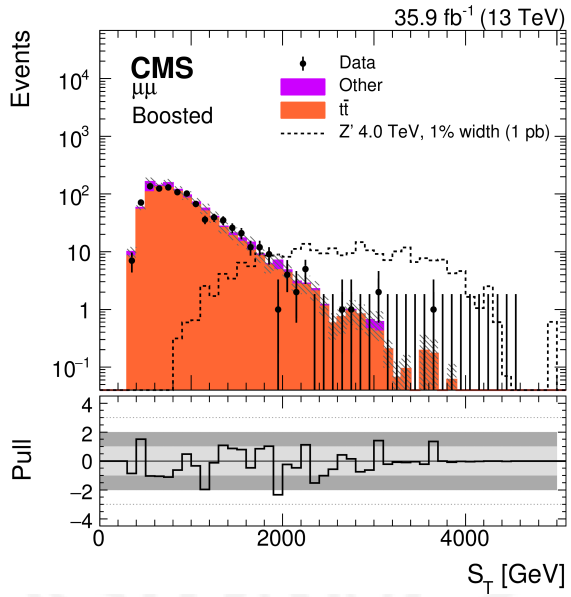




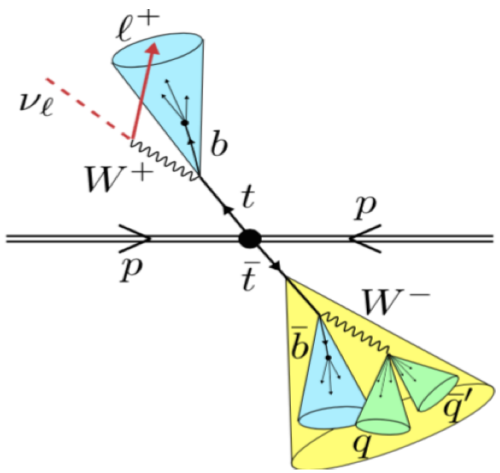
$\mu\mu$

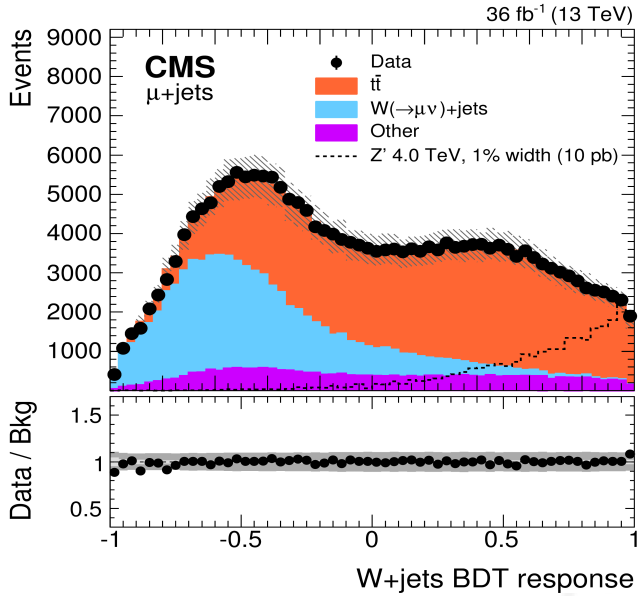




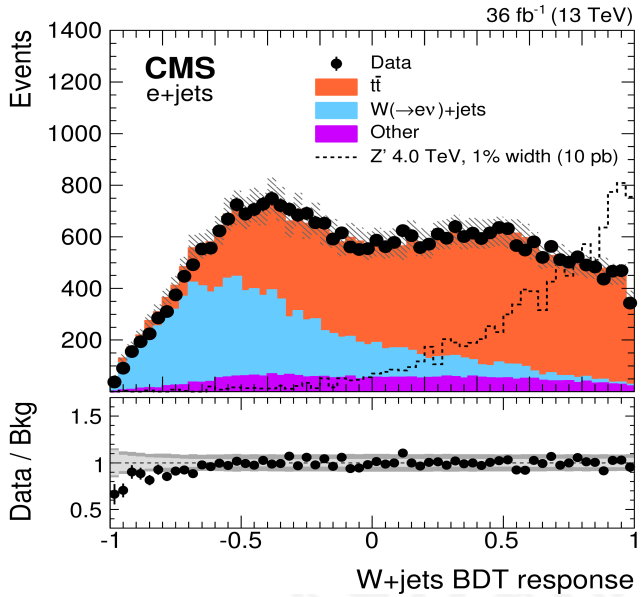


Semileptonic channel: categorization



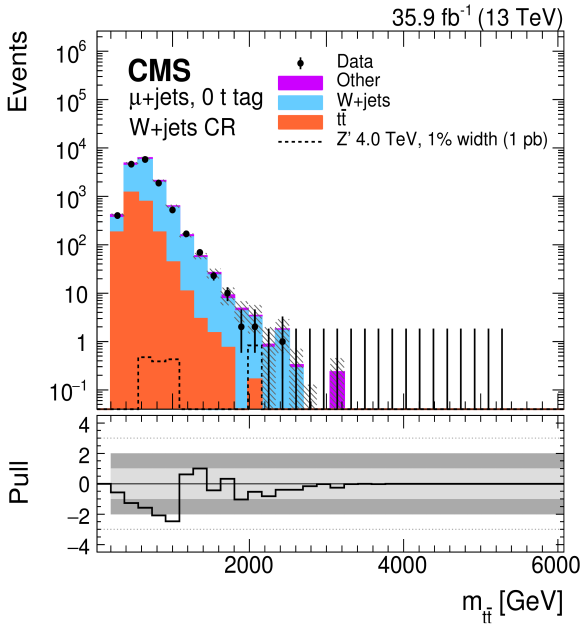


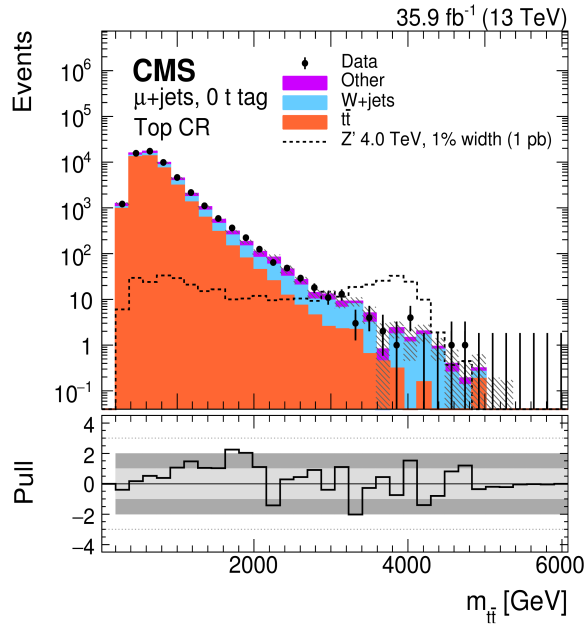
- Defining background/signal regions using discriminator variables:
  - → χ^2
  - → W+jets BDT response
  - → $N_{toptagged}$



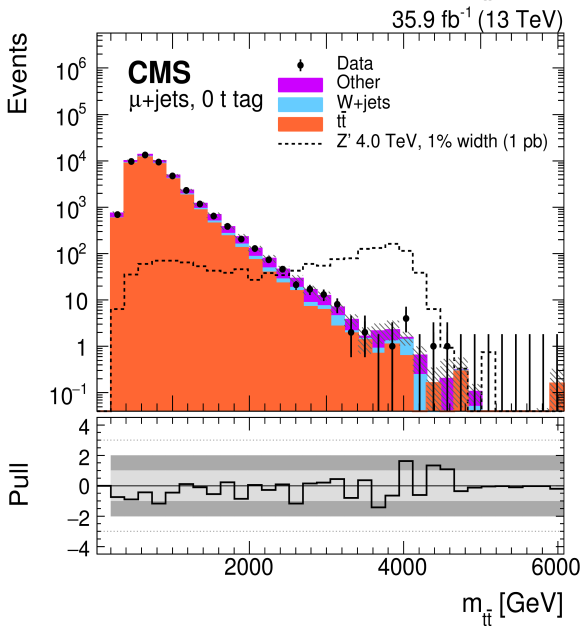
Semileptonic channel: sensitivity variable

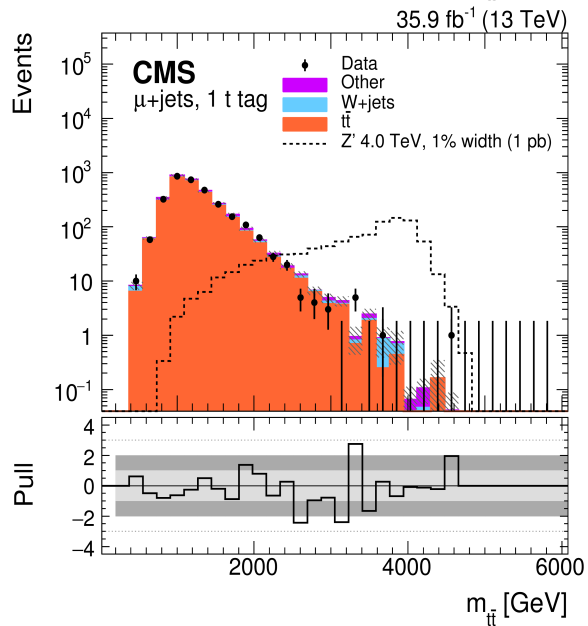
Control Regions



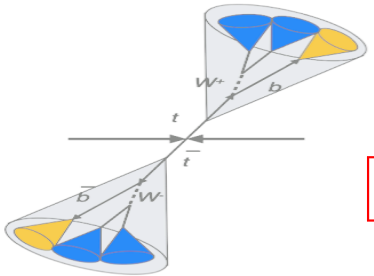


Signal Regions





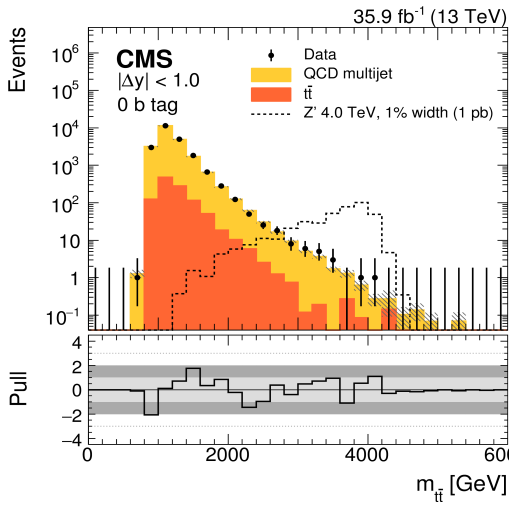
Hadronic channel: categorization

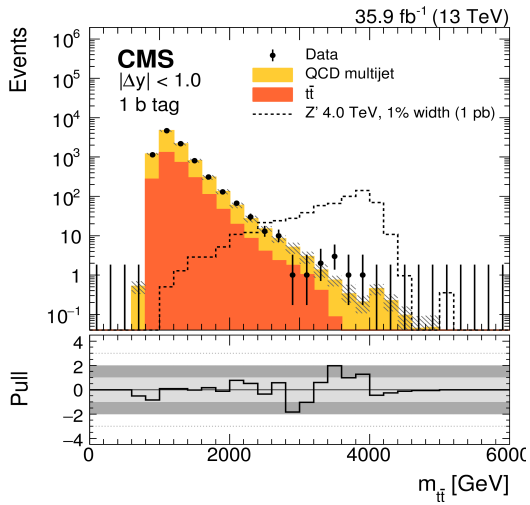


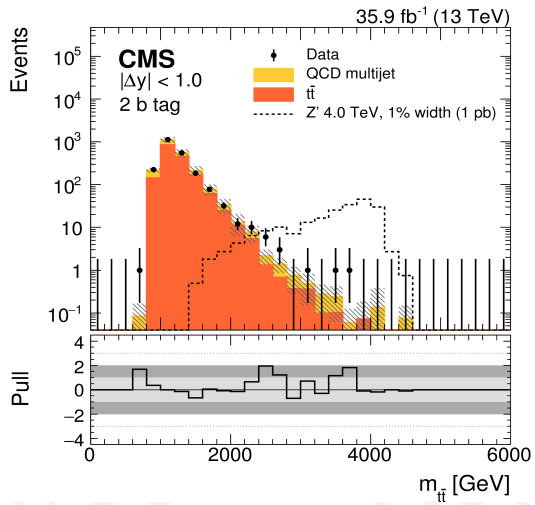
Six event categories defined based on Δy_{jets} and N_b subjet

$N_{b-tagged} = 0$ | $N_{b-tagged} = 1$ | $N_{b-tagged} = 2$

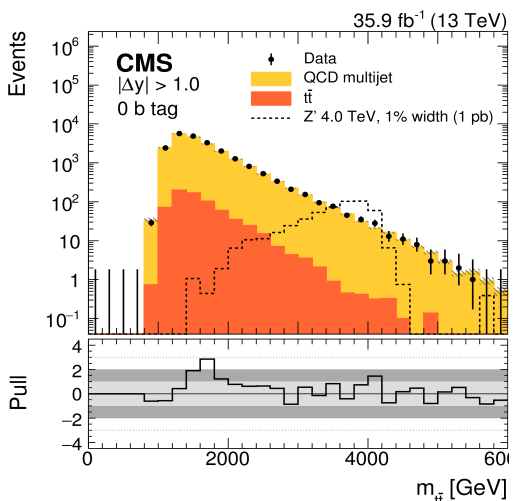
$|\Delta y| < 1.0$

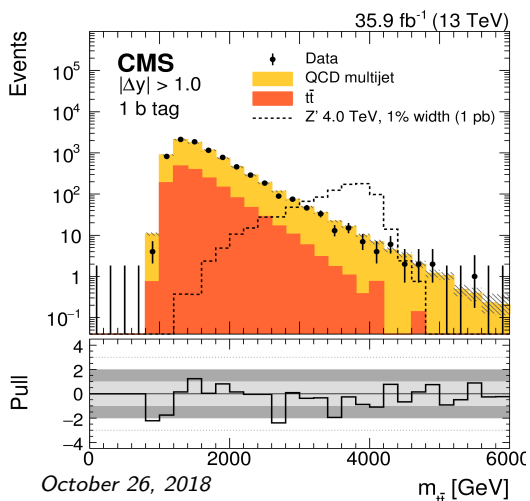


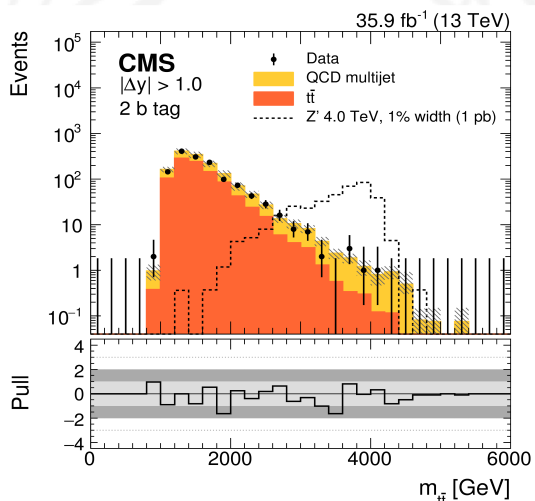




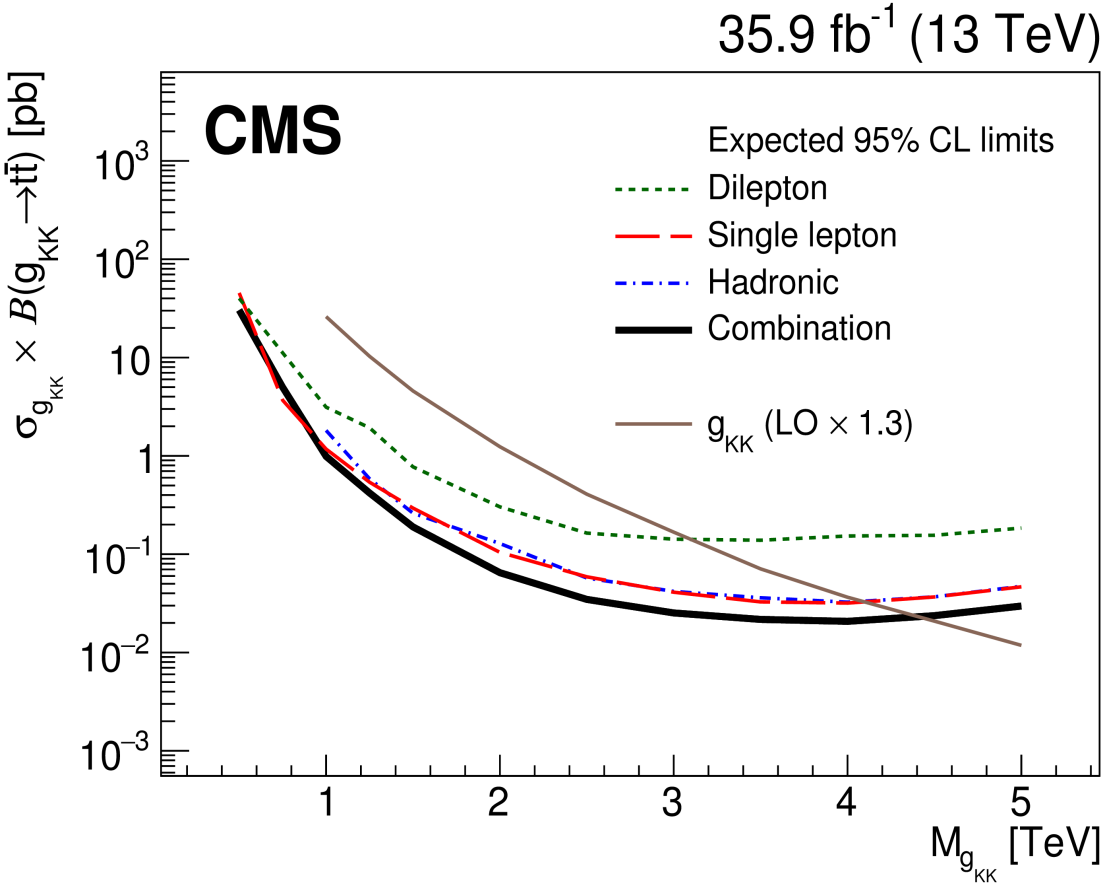
$|\Delta y| > 1.0$







Combination: limits



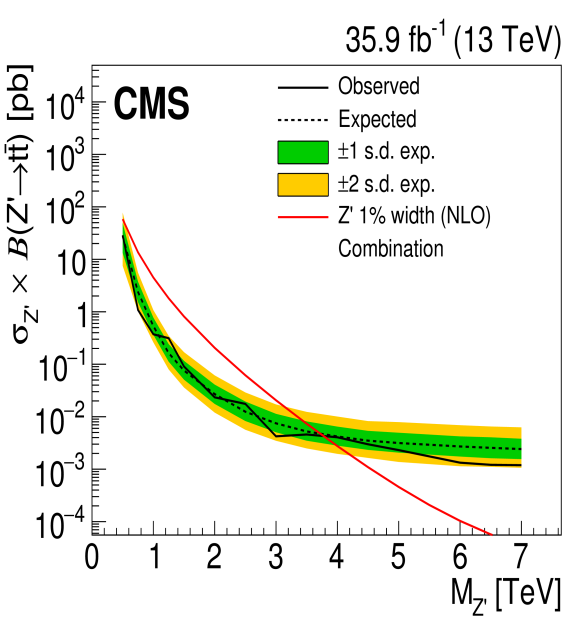
Channel	Expected (TeV)	Observed (TeV)
Leptonic	3.1	3.2
Semileptonic	4.1	4.3
Hadronic	4.1	4.3
Combination	4.45	4.55

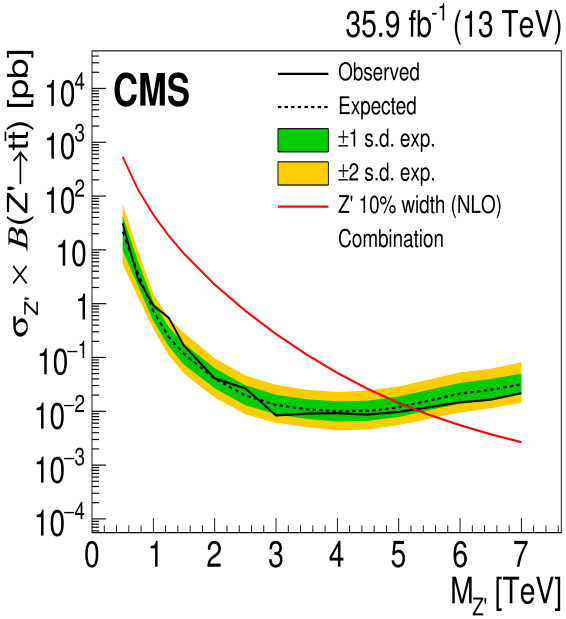
Summary

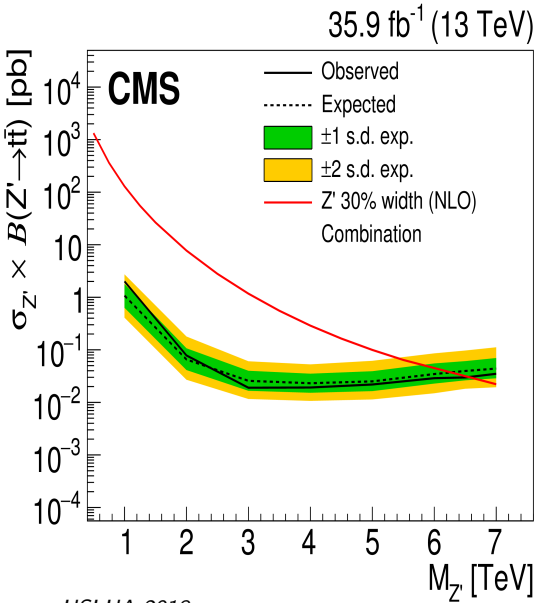
- We searched for heavy $t\bar{t}$ resonances at 13 TeV with 36 fb^{-1} of CMS data
- Search is performed in dilepton, lepton+jet and fully hadronic states
- No deviation is observed over SM expectation
- We set the limits on the heavy $t\bar{t}$ resonance production cross section
- Z' and g_{KK} are excluded within the mass range:
  - $\rightarrow$ Z' ($\Gamma/M = 1\%$): [0.5—3.8] TeV
  - $\rightarrow$ Z' ($\Gamma/M = 10\%$): [0.5—5.0] TeV
  - $\rightarrow$ Z' ($\Gamma/M = 30\%$): [0.5—6.4] TeV
  - $\rightarrow$ g_{KK} : [0.5—4.55] TeV
- These are the stringent limits to date
- Results submitted to JHEP (arXiv:1810.05905)

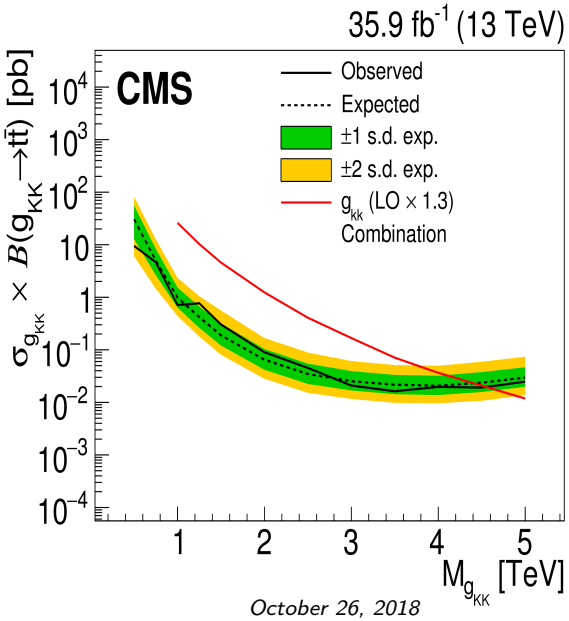
Backup Slides

Limits









Model	Expected (TeV)	Observed (TeV)
$Z'(\Gamma/M = 1\%)$	3.75	3.8
$Z'(\Gamma/M = 10\%)$	5.1	5.25
$Z'(\Gamma/M = 30\%)$	6.4	6.65
g_{KK}	4.45	4.55